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Word, Niche and Super-Niche: How Language Makes Minds Matter More*

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ABSTRACT: How does language (spoken or written) impact thought? One useful way to approach this important but elusive question may be to consider language itself as a cognition-enhancing animal-built structure. To take this perspective is to view language as a kind of self-constructed cognitive niche. These self-constructed cognitive niches play, I suggest, three distinct but deeply interlocking roles in human thought and reason. Working together, these three interlocking routines radically transform the human mind, and mark a genuine discontinuity in the space of animal minds.

Key words: niche construction, cognitive niche, cognition-enhancing structure

> "Evers' mind began to think things over which he had no control….Evers didn't want to think about losing his skin. His mind made him. It also made him think about a Frank Sinatra song in three-quarter time…And bowling balls".
>
> Martin Clark, *The Many Aspects of Mobile Home Living* (Vintage 2001) P.76

1. Niche Construction: A Primer

Niche construction, as defined by Laland *et al.* (1999), refers to:

> "the activities, choices and metabolic processes of organisms, through which they define, choose, modify and partly create their own niches. For instance, to varying degrees, organisms choose their own habitats, mates, and resources and construct important components of their local environments such as nests, holes, burrows, paths, webs, dams, and chemical environments"

Niche construction is a pervasive, though still widely underestimated, force in nature. All animals act on their environments and, in so doing, alter those environments in ways that may sometimes change the fitness landscape of the animal itself. A classic example[1] is the spider's web. The existence of the web modifies the sources of natural selection within the spider's selective niche, allowing (for example) subsequent selection for web-based forms of camouflage and communication. Still further complexity is introduced when organisms collectively build structures that persist beyond their own lifetime. A familiar example is the communally constructed beaver's dam, whose physical presence subsequently alters selection pressures on both the beaver and its

* Thanks to John Protevi for some very useful comments on an earlier draft.

[1] For a host of other examples, see Laland et al (1999). See also Dawkins (1982), Lewontin (1983), Odling-Smee (1988), Laland et al (1996) and Turner (2000).

progeny, who inherit the dam and the altered river flows it has produced. Similar effects can be seen in the nest building activities of many wasps and termites, where the presence of the nest introduced selection pressures for behaviors that regulate nest temperature by (for example) sealing entrances at night (Frisch 1975). The cultural transmission of knowledge and practices resulting from individual lifetime learning, when combined with the physical persistence of artifacts, yields yet another source of potentially selection-impacting feedback. The classic example here (from Feldman & Cavalli Sforza, 1989) is the practice of domesticating cattle and dairying, which paved the way for selection for adult lactose tolerance in (and only in) those human populations engaging in such activities.

In all these cases, what ultimately matters, as Laland et al (1999) stress, is the way niche-construction activity leads to new feedback cycles. In the standard cases, these feedback cycles run across evolutionary time. Animals change the world in ways that change the selective landscapes for biological evolution. Importantly for our purposes, however, this whole process has a direct analogue within lifetime learning. Here, the feedback cycles alter and transform processes of individual and cultural learning. For example, both educational practices and human-built structures (artifacts) are passed on from generation to generation in ways that dramatically alter the fitness landscape for individual lifetime learning. To adapt an example I have used elsewhere (Clark (2001)), the novice bartender inherits an array of differently shaped glassware and cocktail furniture, and a practice of serving different drinks in different kinds of glass. As a result, expert bartenders (see Beach (1988)) learn to line up differently shaped glasses in spatial sequence corresponding to the temporal sequence of drinks orders. The problem of remembering what drink to prepare next is thus transformed, as a result of learning within this pre-structured niche, into the problem of perceiving the different shapes and associating each shape with a kind of drink. This process can even (or so I am told) be fine-tuned by the judicious use of different cocktail furniture (those tiny umbrellas etc) to offload information about increasingly subtle differences between the orders. A second example, this time simulation-based, is the demonstration (Hutchins and Hazlehurst (1991)) that the generation, selection and 'passing down' of persisting artifacts (time/tide tables in a population of simulated mariners) leads to faster learning and improved problem-solving: the gradual sedimentation of additional artifactual structure in the learner's environment allows agents in subsequent generations to learn to solve problems that were effectively unsolvable before, yet with no genetic change whatsoever.

The bartender/simulated seafarer examples are simple illustrations of the power of 'cognitive niche construction', hereby defined as the process by which animals build physical structures that transform problem spaces in ways that aid (or sometimes impede) thinking and reasoning about some target domain or domains[2]. These physical

[2] The idea of humans as cognitive niche constructors is familiar within cognitive science. Richard Gregory (1981) spoke of 'cognition amplifiers', Don Norman(1993) of 'things that make us smart', Kirsh and Maglio (1994) of 'epistemic actions', Daniel Dennett (1996) of 'tools for thought'.

structures combine with appropriate culturally transmitted practices to enhance[3] problem-solving, and (in the most dramatic cases) to make possible whole new forms of thought and reason. In the rest of this short essay, I ask what happens if we take one step back from the realm of standard material artifacts and treat language itself, both spoken and written, as an instance of cognitive niche[4] construction.

2. Three Benefits of the Linguistic Niche

Language, like the beaver's dam, is a collectively constructed trans-generational phenomenon. But human language, unlike the beaver's dam, provides our species with a distinctive, general purpose cognitive niche: a persisting, though never stationary, symbolic edifice whose critical role in promoting thought and reason remains surprisingly ill-understood. This cognitive niche plays, I want to suggest, at least three distinct but interlocking roles in thought and reason.

First Role: An Augmented Reality Overlay

I have written quiet a bit on this elsewhere, so I'll keep this brief. The central idea is that the act of labeling creates a new realm of perceptible objects upon which to target basic capacities of statistical and associative learning. The act of labeling thus alters the computational burdens imposed by certain kinds of problem. An example of this (Clark (1998)) begins with the use, by otherwise language-naïve chimpanzees, of concrete tags (simple and distinct plastic shapes) for relations such as sameness and difference. Thus, a pair such as cup/cup might be associated with a red triangle (sameness) and cup/shoe with a blue circle (difference). This is not in itself surprising. What is more interesting is that after this training, the tag-trained chimps (and only tag-trained chimps) prove able to learn about the abstract properties of higher-order sameness, i.e. they are able to learn to judge of two presented pairs (such as cup/cup and cup/shoe) that the relation between the relations is one of higher order difference

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[3] My goal in this treatment is to suggest some of the positive ways in which the communally constructed linguistic niche transforms thought, reason and problem-solving. But it is also important to notice (and thanks to John Protevi for insisting on this) that these same socio-historically constructed linguistic scaffoldings also promote a wide variety of cognitive-affective structurings, many of which have negative, rather than positive, effects. The potential for negative effects is especially clear in matters concerning race, gender and class. For example, think of the many ways in which specific features either of a language or of local linguistic use (such as the default use of the masculine) can contribute to the disempowerment of whole swathes of the community. Hopefully, better appreciating the potent cognitive role of language will make us increasingly alert to these issues, and more willing and able to pursue appropriate kinds of intervention and change.

[4] Pinker (see eg Pinker (2003)) speaks of language as an adaptation to the the cognitive niche. By this, he means that language evolved by natural selection to support our heavily knowledge-based lifestyle. The idea I am pursuing is different. It is that language itself acts as a new kind of (self-created) niche that radically alters the landscape upon which human cognition is targeted. Language is thus more like the beaver's dam than the finch's beak. This latter idea is consistent with the claim that the key features of language do not reflect domain-specific adaptations at all (see Kirby and Christiansen (2003) for the kind of account I have here in mind).

(or better, lack of higher-order sameness) since the first pair exhibits the sameness relation and the second pair the difference relation (Thompson, Oden and Boysen (1997)). The reason the tag-trained chimps can perform this surprising feat is, so the authors suggest, because by mentally recalling the tags the chimps can reduce the higher order problem to a lower order one: all they have to do is spot that the relation of difference describes the pairing of the two recalled tags (red triangle and blue circle).

This is a nice concrete example of what may well be a very general effect (see Clark (1997) Dennett (1993)). Once fluent in the use of tags, complex properties and relations in the perceptual array are, in effect, artificially re-constituted as simple inspectable wholes. The effect is to reduce the descriptive complexity of the scene. In a classic paper, Kirsh (1995) describes the intelligent use of space in just these terms. When, for example, you group your shopping in one bag and mine in another, or when the cook places washed vegetables in one location and unwashed ones in another, the effect is to use spatial organization to simplify problem-solving, by using spatial proximity to reduce descriptive complexity. It is intuitive that once descriptive complexity is thus reduced, processes of selective attention, and of action-control, can operate on elements of a scene that were previously too 'unmarked' to define such operations over. Experience with tags and labels may be a cheap way of achieving a similar result.

In fact (see Clark, forthcoming) the cognitive functions of space and labels are strikingly similar. Each is usefully conceived as a resource for reducing descriptive complexity. Spatial organization reduces descriptive complexity by means of physical groupings that channel perception and action towards functional or appearance-based equivalence classes. Labels allow us to focus attention on all and only the items belonging to equivalence classes (the red shoes, the green apples etc). In this way, both linguistic and physical groupings allow selective attention to dwell on all and only the items belonging to the class. And the two resources work in close co-operation. Spatial groupings are used in teaching children the meanings of words, and mentally rehearsed words may be used to control activities of spatial grouping. In this way, the intelligent use of space and the intelligent use of language may form a mutually reinforcing pair, pursuing a common cognitive agenda.

Simple labeling thus functions as a kind of augmented reality[5] trick by means of which we cheaply and open-endedly project new groupings and structures onto a perceived scene. Labeling is cheap since it avoids the physical effort of actually putting things into piles. And it is open-ended insofar as it can group in ways that defeat simple spatial display: for example, by allowing us to selectively attend to the four corners of a tabletop, an exercise that clearly cannot be performed by physical reorganization! Linguistic labels, on this view, are tools for grouping, and in this sense act much like real spatial re-organization. But in addition (and unlike physical groupings) they effec-

[5] An example of such a display would be the projection, on demand, of green arrows marking the route to a university library onto a glasses-mounted display. The arrows would appear overlaid upon the actual local scene, and would update as the agent moves.

tively and open-endedly add new items (the recalled labels themselves) to the scene. In this way, experiences with tags and labels warps and reconfigures the problem spaces for the cognitive engine.

Second Role: Scaffolding Action and Attention

The role of structured language as a tool for scaffolding action has been explored in a variety of literatures, ranging from Vygotskyian developmental psychology to cognitive anthropology[6]. Mundane examples of such scaffolding abound, and range from memorized instructions for tying ones shoelaces (for some detailed analysis and discussion see Mascalo and Cowart (In Progress)) to mentally rehearsed mantras for crossing the road, such as " look right, look left, look right again and if all is clear cross with caution" (that's for UK-style left-hand drive roads: don't try that in the USA folks!). In such cases, the language-using agent is able (once the instructions are memorized, or, in the written case, visually accessed) to engage in a simple kind of behavioral self-scaffolding, using the phonetic or spatial sequence of symbolic encodings to stand proxie for the temporal sequence of acts. Frequent practice then enables the agent to develop genuine expertise, and to dispense with the rehearsal of the helpful mantra.

Potentially more interesting than all this, however, is the role of linguistic rehearsal in expert performance itself. In previous work (Clark (1996)) I discussed some ways in which linguaform rehearsal enables experts to temporarily alter their own focus of attention, thus fine-tuning the patterns of inputs that are to be processed by fast, fluent, highly trained subpersonal resources. Experts, I argued, are doubly expert. They are expert at the task in hand, but also expert at using well-chosen linguistic prompts and reminders to maintain performance in the face of adversity. Sometimes, inner rehearsal here plays a distinctly affective role, as the expert encourages herself to perform at her peak[7]. But in addition to the important cognitive-affective role of inner dialogue, there may also be cases in which verbal rehearsal supports a kind of perceptual structuring via the controlled disposition of attention (for a nice example, see the discussion of linguistic rehearsal by expert Tetris players in Kirsh and Maglio (1992)). The key idea, once again, is that the linguistic tools enable us to deliberately and systematically sculpt and modify our own processes of selective attention.

Recent work by Hermer-Vazquez, Spelke, and Katsnelson (1999) sheds further light on the power and ubiquity of this strategy. In this study, pre-linguistic infants were shown the location of a toy or food in a room, then were spun around or otherwise disoriented and required to try to find the desired item. The location was uniquely determinable only by remembering conjoined cues concerning the color of the wall and its geometry (eg the toy might be hidden in the corner between the long wall and the short blue wall). The rooms were designed so that the geometric or color

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[6] See, for example, Berk (1994), Hutchins (1995), Donald (2001).

[7] Here too, as John Protevi (personal communication) reminds me, the impact is not always positive. We can just as easily derail our own performance by explicit reflection on our own shortcomings.

cues were individually insufficient, and would yield an unambiguous result only when combined together. Prelinguistic infants, though perfectly able to detect and use both kinds of cue, were shown to exploit only the geometric information, searching randomly in each of the two geometrically indistinguishable sites. Yet adults and older children were easily capable of combining the geometric and non-geometric cues to solve the problem. Importantly, success at combining the cues was not predicted by any measure of the children's intelligence or developmental stage except for the child's use of language. Only children who were able to spontaneously conjoin spatial and (e.g.) color terms in their speech (who would describe something as, say, to the right of the long green wall) were able to solve the problem. Hermer-Vazquez et al (op cit) then probed the role of language in this task by asking subjects to solve problems requiring the integration of geometric and non-geometric information while performing one of two other tasks. The first task involved shadowing (repeating back) speech played over headphones. The other involved shadowing, with their hands, a rhythm played over the headphones. The working memory demands of the latter task were at least as heavy as those of the former. Yet subjects engaged in speech shadowing were unable to solve the integration-demanding problem, while those shadowing rhythm were unaffected. An agents linguistic abilities, the researchers concluded, are indeed actively involved in their ability to solve problems requiring the integration of geometric and non-geometric information.

The precise nature of this linguistic involvement is, however, still in dispute. Hermer-Vazquez, Spelke, and Katsnelson (1999), and following them Carruthers (2002), interpret the results as suggesting that public language provides the unique internal representational medium (at least in humans) for the cross-modular integration of information. Perceptually encountered or recalled sentences are, according to Carruthers, the special representational vehicles that allow information from otherwise encapsulated and that allow isolated cognitive modules to enter into a unified inner representation. But such an account, it seems to me, buys too heavily into a specific (and quite contentious- see Fodor (2001)) view of the mind as massively (not merely peripherally) modular, requiring linguaform templates to bring multiple knowledge bases into fruitful contact.

Suppose we abandon this presupposition of massive modularity? We may still account (or so I suggest) for the role of language in enabling complex multi-cued problem solving, by depicting the linguistic structures as providing essential scaffolding for the distribution of selective attention to complex (in this case color/geometry conjunctive) aspects of the scene. According to this alternative account, linguistic resources enable us better to control the disposition of selective attention to ever-more complex feature combinations[8]. Attention to a complex conjoined cue, I suggest, requires the (possibly unconscious) retrieval of at least some of the relevant lexical

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[8] In partial support of this claim, notice that there is good evidence that children show attentional biases that are sensitive to the language they are learning (or have learnt)- see Bowerman and Choi (2001), Lucy and Gaskins (2001) and Smith (2001). Smith (2001 p.113) explicitly suggests that learnt linguistic contexts come to "serve as cues that automatically control attention".

items. This explains the shadowing result. And it fits nicely with the earlier account of the cognitive impact of simple labels insofar as linguistic activity (in this case more structured activity) again allows us to target our attentional resources on complex, conjunctive, or otherwise elusive, elements of the encountered scene.

Third Role: Self-Knowledge and Mind Control

Judge Evers, in the opening quote, complains that his mind is making him think about things. The human ability to feel either in control or (disturbingly) not in control of our own thinkings is, I have long believed, indicative of something special and extraordinarily potent in human cognition. This something seems profoundly, and perhaps inextricably, bound up with the human capacity to use linguistic rehearsal as a means of directing our own thought and reasoning. The idea I would now like to pursue, very briefly and inadequately, is that linguistic rehearsal provides a means of controlling or scaffolding *inwardly-directed* attentional processes, and hence of indirectly manipulating our own minds.

Daniel Dennett, in one of his many attempts to dy-mystify qualitative consciousness, notes that:

> "among the many discriminative states that our bodies may enter….a subset of them can be discriminated in turn by higher-order discriminations which then become sources of guidance for higher level control activities [ ]If somebody throws a brick at you, you see it coming and duck. But you also discriminate the fact that you visually discriminated the projectile, and can then discriminate the further fact that you can tell visual from tactile discriminations (usually), and then go on to reflect on the fact that you are also able to recall recent sensory discriminations in some detail, and that there is a difference between experiencing something and recalling the experience of something, and between thinking about the difference between recollection and experience and thinking about the difference between seeing and hearing, and so forth, till bedtime". Dennett (2001).

This recursive spiral of self-monitoring is, Dennett believes, the key to understanding consciousness itself[9]. What matters for current purposes, however, is that these capacities of self-monitoring are arguably very deeply bound up with our linguistic skills, and that this kind of linguistically-mediated self-monitoring provides us with some rather special capacities for self-control.

To illustrate the process I have in mind, consider a freshly tweaked version of an old story by Daniel Dennett. Dennett (1985) asks us to imagine a chess-playing program that appears (when viewed from the intentional stance) to believe that it should get its queen out early. But despite this pattern in its behavior, Dennett assures us that there is no explicit line of code or other data-structure that means 'get your queen out early'. Instead, this (dangerous and unwholesome) behavior is an emergent effect of many other lines of code, about quite different things and strategies. So far so familiar. Now imagine that the chess playing agent is a human being. The human player, after several painful losses, may observe the pattern or be told about it. At this point, she comes to believe[10] that she is prone to getting her queen out early. In the early stages

[9] I tend to agree. For my own best shot at telling such a story, see Clark (2000).

[10] Dennett would say "she comes to have the opinion that…" See Dennett (1991).

of subsequent games, whenever she reaches for her queen, the sentence flashes through her head "don't get your queen out early". With sufficient practice, she may learn a set of strategies whose emergent outcome is that she will not normally get the queen out early. At that point, the sentential prop can be kicked away (though others, appropriate to her new stage of expertise, may take its place).

This kind of story about the development of expertise is often told in ways that downplay the importance of linguaform rehearsal, depicting it as just a tool for the novice (eg Dreyfus and Dreyfus (2000)). But this is premature modesty. First, and following on from our earlier discussion, exposure to tags and labels may sometimes be essential to the formation of many of the higher level concepts that figure in many of these episodes of self-control. And second, the process of making explicit (and hence open to attempts at direct control) what was previously just an emergent pattern in behavior[11] seems much more than a tool for the novice. Instead, it is central to much of what matters most about the human mind and about human life viz our unique capacity to hold ourselves morally responsible for our own deeds and actions. Such responsibility makes sense only in the presence of some degree of possible control, and linguaform thought and reason, as the chess-playing case suggests, is one of the key resources that unlocks the space of open-ended self-awareness and self-control.

This capacity can also be turned inwards, as we attempt to track and control not just our overt actions but also our habits of thought. A human agent can, for example, decide not to revisit a certain difficult decision. Very often, to be sure, we fail in such attempts. The real surprise, though, is that we can sometimes, and to some degree, succeed! When we do so, it is often introspectively the case that we succeed by being alert to revision-prompting situations and mentally rehearsing, at such times, our decision not to revisit the decision in its full complexity[12]. Similar strategies are often used to avoid full recall of especially painful memories. Shallow linguaform rehearsal, in both these cases, acts as a kind of barrier between mere cognizance and full, rich recall. This may be a high-level version of the effect most famously seen in the numeral-savvy chimpanzee Sheba. In a series of experiments (Boysen et al (1996)), Sheba was offered two trays laden with sweets. But to get the tray containing the greater number, she was required to point to the tray containing less. This proved impossible, until the trays were covered with cardboard tops marked with a numeral indicating the number of sweets on the tray. At that point, Sheba was able to overcome her immediate urges and select the lesser number (thus gaining the full reward). The presence of the numeral, as a kind of intervening layer between perception and action, thus enabled Sheba to maintain control over her own intuitive response. Language and symbolic representations may thus act as a kind of affect-dampening layer of insulation, enabling us to pursue our goals without becoming repeatedly entrapped by our own more

[11] For an extended discussion of this, see Clark and Karmiloff-Smith (1993) and also Dennett's comments in Dennett (1993).

[12] Holton (forthcoming) has a nice discussion of some related cases involving techniques for sticking to one's resolutions.

immediate urges and tendencies, be they overt (as in the case of Sheba and the treats) or covert (as in the case of unwanted recall).

In a recent discussion, O'Brien and Opie (2002) extend this kind of conception of language and control even further, arguing that:

> "the internalisation of natural language is a process whereby a conventionally governed set of communicative signals is put to work inside a single brain. Language becomes a system of signals apt not only for manipulating the brains of others, but also for recurrent self-manipulation. Such internalisation involves establishing communicative links (routed through the language centres) that can be employed by one part of the brain to steer the cognitive activities occurring in other parts of the brain". O'Brien and Opie (2002) .

O'Brien and Opie depict internalized language as performing its cognition-enhancing role by creating patterns co-ordinated activity spanning many modalities and neural regions[13]. In the next and final section, I shall argue that internalized language plays the additional, and equally important, role of disciplining the representational states and trajectories proper to the various neural regions themselves. That is, that we use internalized linguistic routines to productively dampen and control (but not counter-productively destroy altogether) the fluidity and context-sensitivity of biologically basic forms of neural representation.

Putting all this together, language emerges as an incredibly potent resource for self-control. It enables us to make hidden or emergent patterns in our own actions explicit. And by so doing, it enables us to begin to control and alter those patterns. It does this by making them into objects for thought, and by partially detaching those objects from their full range of affective impact. This whole complex of control-oriented virtues then reapplies to the inner realm[14], where linguaform rehearsal is revealed as a flexible tool for the iterated and systematic manipulation of our own habits of thought.

3. From Translation to Co-ordination

What general model of language and its relation to thought do these various illustrations suggest? A good place to begin is with the conception of language as complementary to more basic forms of neural processing. According to this conception (Clark (1997) (2001) (2003)) language works its magic not by means of translation into matching expressions of an inner code or Language of Thought, but by something more like co-ordination dynamics. Encounters with words and with structured linguistic encodings act so as to anchor and discipline intrinsically fluid and context-sensitive modes of thought and reason.

This notion of anchoring is best appreciated in the light of connectionist or artificial neural network models of memory, storage and processing (for basic overviews, see Clark (1989) (1993). For something closer to the state of the art, see O'Reilly and

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[13] For more on this, O' Brien and Opie (forthcoming) refer the reader to discussion in Damasio (1994).

[14] What is on offer is thus a broadly Vygotskian view of the role of language in thought. See Vygotsky (1978) (1986). For a contemporary assessment, see Berk (1994).

Munakata (2000)). For present purposes, what matters is that such models posit a fundamentally fluid system in which the fine details of recent context color and nuance recall and representation in quite fundamental ways. For systems such as these, the problem of *stabilization* becomes pressing. On the one hand, it is a virtue of these systems that new information automatically impacts similar items that are already 'stored', and that information retrieval is highly context-sensitive. On the other hand, advanced thought and reason plausibly requires the capacity to repeatedly revisit and inspect old ideas and trains of thought, both for critical assessment and systematic expansion. It requires the ability to reliably follow trajectories in representational space, and to reliably lead others through certain trajectories. All this requires some means to discipline our own, and others', mental spaces in ways that tame (though never eradicate) those biologically more 'natural' processes of merging and change. Words and linguistic strings are among the most powerful and basic tools that we use to discipline and stabilize dynamic processes of reason and recall. Both between agents and within a single agent, streams of words act as reliable signposts to recovered meanings, while still allowing those meanings to shift and color according to context. Sustaining this balance between rote retrieval and anarchic context-sensitivity is, I believe, the key trick that public language performs for minds like ours.

The shift is thus from seeing words and sentences as items apt only for translation into an inner code, to seeing them as inputs (whether externally or internally generated) that drive, sculpt and discipline the internal representational regime. In just this vein, Elman (2004) suggests that:

> "Rather than putting word knowledge into a passive storage (which then entails mechanisms by which that knowledge can be 'accessed', 'retrieved', 'integrated' etc) words might be thought of in the same way that one thinks of other kinds of sensory stimuli: they act directly on mental states" Elman (2004), p. 301.

"Words" Elman goes on to argue "do not have meaning, they are cues to meaning"[15] (op cit p.306). This rather radical re-conception of language provides, it seems to me, the most natural way to make sense of the panoply of effects scouted above. Linguistic inputs, on this model, are quite literally modes of systematic neural manipulation, and operate in similar ways both between and within human individuals. Words and sentences thus act as artificial input signals, often entirely self-generated, that nudge fluid natural systems of encoding and representation along reliable and useful trajectories. This remarkable display of virtuouso artificial self-manipulation allows language-laden minds to sculpt and guide their own processes of learning, of recall, of representation, and of selective attention.

Conclusions: Niche and Super-Niche

Language, I have tried to show, is usefully understood as an animal-built material structure (a cognitive niche) that systematically alters the computational burdens in-

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[15] Elman cites Dave Rumelhart both for this phrasing and for the guiding conception of words as cues to meanings.

volved in learning, reasoning and self-control. In this respect language stands to thought as a self-constructed behavior-enhancing niche stands to its animal 'occupant'. But language is also special, in at least two crucial respects. First, courtesy of those repeated processes of internalization and inner rehearsal, language straddles the boundaries between inner and outer, acting both as a self-constructed niche, and then as part and parcel of the niche-occupying animal. This gives rise to a potent and iterated series of ratchet effects in which we first build the cognitive niches that then build us. Second, language is the key cognitive tool by means of which we are able to objectify, reflect upon, and hence knowingly engage with, our own capacities of thought, reason and self-control. This positions language to act as a kind of cognitive super-niche: a cognitive niche whose main effect is to allow us to construct ('with malice aforethought', as Fodor (1994) efficiently puts it) an open-ended sequence of new cognitive niches, new training regimes and designer environments in which to think, reason and perform. Finally, this whole process has an inward-looking analogue. Language acts as a tool that enables us to think about any aspect of our own thinking, and thus to devise cognitive strategies (which may be more or less indirect and baroque) aimed to modify, alter, or control just about any aspect of our own inner life. Such attempts at self-control, though dizzingly open-ended, are visibly (and often painfully) imperfect. But imperfect or not, they represent, I want finally to suggest, a genuine leap in the design space of possible minds. Our language-using minds, alone in the animal kingdom, are partially self-transparent, and poised for stacked and iterated processes of self-guided change.

Getting to grips with our own special cognitive nature demands that we take very seriously the material reality of language: its existence as additional, actively created and effortfully maintained structure in our internal and external environment. From sounds in the air, to inscriptions on the printed page, the material structures of language both reflect, and then systematically transform, our thinking and reasoning about the world. As a result, our cognitive relation to our own words and language (both as individuals and as a species) defies any simple logic of inner versus outer. Linguistic forms and structures are first encountered as simply objects (additional structure) in our world. But they then form a potent overlay that effectively, and iteratively, reconfigures the space for biological reason and self-control.

Time then to close and take stock. This has been a comprehensive, and hence rather a whirlwind tour. Large amounts of important detail are missing and many pressing questions remain unanswered. It would be good to have a clear account of just what attention, that crucial variable that linguistic scaffolding seems so potently to adjust, actually *is*. It would be good to have a genuine, implementable, fully mechanistic model of how internalized language intelligently directs thought. It would be good to know what it is, about human brains and/or human history, that has enabled structured language to get such a comprehensive grip on minds like ours. Lacks and lacunas visibly abound. I hope, however, to have made plausible two mutually-supporting claims. The first is that it is fruitful to think about language as a cognition-transforming animal-built structure. The second is that language transforms cognition by acting as a quasi-sensory source of structuring and stabilizing input (rather than as a code apt for translation into some content-matching inner format). These twin moves have, I believe, important implications for philosophical conceptions of the relation between language and thought, for attempts to understand the notions of self-control and of moral responsibility, and for ongoing debates concerning the continuities and discontinuities between the human mind and the minds of other animals. Developing tools, techniques and conceptualizations adequate to the spiraling and mutually transformative dynamics of thought, language and self-control remains a major challenge for a mature science and philosophy of the human mind.

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